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## OBSERVATIONS ON THE FOREIGN OBJECTS CARRIED BY THE PURPLE-TIPPED SEA-URCHIN.

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THE common Purple-tipped Sea-Urchin (*Echinus miliaris*) has a well-known habit of carrying various objects, which presumably act as a disguise, upon the upper parts of its body. These objects are usually stones, seaweeds, or shells, but the animal may pick up anything which lies in or close to its path as it creeps along, or which lies near its resting-place. In addition to pebbles and seaweed, I have seen the following materials carried by captive individuals of this Sea-Urchin: a bunch of about fifty eggs of the Sea-Bullhead (*Cottus bubalis*), a living *Ascidia* sp., a Tube-Worm (*Sabella pavonina*) of about seven inches in length, a Hydroid (*Sertularia operculata*), a living Dog-Periwinkle (*Nassa reticulata*), a living Dog-Whelk (*Purpura lapillus*), empty shells of *Nassa*, *Purpura*, *Rissoa membranacea*, *Trochus cinerarius*, and *T. zizyphinus*, fragments of the shells of various molluscs, and pieces of the broken test of the Edible Sea-Urchin (*Echinus esculentus*).

It seemed to me to be desirable, for reasons which will be mentioned later, to obtain a number of fresh Sea-Urchins, to keep them under constant observation, to make as far as possible detailed notes of their behaviour, and to keep records of the materials which they picked up. Twelve individuals were taken in a dredge from a part of the estuary at Walton-on-the-Naze (Essex) where there is a bottom of gravel. The long diameters (excluding the spines) of these Sea-Urchins were 10, 15, 19, 21, 21, 21, 23, 23, 23, 27, 27, and 39 millimetres respectively. The weights of the three first were 0·7, 1·7, and 4·3 grammes, the

average weight of the three individuals of 21 mm. was 5·6 gr.\*; the average weight of the three individuals of 23 mm. was 8·0 gr.; the weight of those of 27 mm. was 12·7 gr.; the weight of the individual of 39 mm. (which was dead before the records were actually begun) was not taken. The Sea-Urchins were placed in an aquarium which stood in a fairly dark spot (lighted when necessary by an electric lamp above). This tank held nearly thirty gallons of well-aerated and gently-circulating sea-water, which as far as possible was maintained of a uniform salinity throughout the investigations. The floor of the aquarium was covered to a depth of about an inch and a half with small pebbles†; and the tank contained scattered rocks, seaweed, living gastropods (*Nassa reticulata*, *Purpura lapillus*, *Murex erinaceus*, *Trochus cinerarius*, and *Littorina littorea*), empty shells of these gastropods, several *Sabellæ*, and about twenty individuals of the Starfish known as *Asterina gibbosa*. The Sea-Urchins were well fed with raw beef and seaweeds, and were plentifully supplied with the broken shells and echinoderm skeletons which the Sea-Urchins eat in considerable quantities.

The aquarium was searched every morning (excluding Sundays), and any Sea-Urchin which was found to be carrying materials picked up since the last examination was removed from the tank, and the animal and the materials were weighed in a small vessel of sea-water. The observations were carried on for thirteen weeks, but as the results obtained were always of the same general character, it seems unnecessary to present more than a portion of the records made. During the first twenty-eight consecutive days (from June 30th to July 27th inclusive) eighty records of the kinds and weights of objects carried were registered, and these are as follows:—

\* The individuals of 21 mm. were so much alike that it was difficult to distinguish between them, and the same remarks apply to those of 23 and 27 mm. The weights of all the Sea-Urchins differed slightly at different times. Average weights have therefore been given in all cases.

† If the convenient standards introduced by E. J. Allen ("On the Fauna and Bottom-deposits near the 30-fathom line, &c.," 'Jour. Mar. Biol. Assoc.,' vol. 5, N.S., 1897-9, pp. 365-542) are used, most of these stones would come under the head of "medium gravel" and "coarse gravel." Allen describes as coarse gravel the stones which are left in a sieve with holes of 5 mm., and as medium gravel those which are left in a sieve with holes of 2·5 mm. (p. 378).





# OBJECTS CARRIED BY THE SEA-URCHIN.

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## SEA-URCHIN OF 10 MM. WEIGHING 0.7 GR.

No.	Objects carried.	Weights of objects.	Calculated proportion between weight of objects and weight of animal.
		GR.	
1	1 pebble .....	0.1	0.142
2	14 pebbles .....	1.1	1.571
3	4 " piece of seaweed .....	0.5	0.714
4	4 " .....	0.3	0.428
5	10 " piece of seaweed .....	1.1	1.571
6	9 " .....	1.0	1.428
7	21 " .....	1.8	2.571
8	15 " .....	1.9	2.714
9	12 " .....	1.2	1.714
10	10 " .....	1.0	1.428
11	12 " piece of seaweed .....	2.4	3.428
12	9 " .....	1.0	1.428
13	4 " .....	0.3	0.428
14	9 " .....	1.2	1.714
15	13 " .....	1.8	2.571
16	8 " .....	1.3	1.857
17	11 " .....	1.0	1.428
Greatest weight carried, 2.4 gr.		Least weight carried, 0.1.	Average weight carried, 1.117.
			Average proportion, 1.596.

## SEA-URCHIN OF 15 MM. WEIGHING 1.7 GR.

1	4 pebbles .....	2.5	1.470
2	2 " .....	0.7	0.411
3	1 pebble .....	0.1	0.058
4	5 pebbles .....	0.8	0.470
5	5 " .....	0.6	0.352
6	Empty shell of <i>Nassa</i> .....	0.8	0.470
7	8 pebbles .....	—	—
8	7 " .....	—	—
9	10 " .....	—	—
10	6 " .....	—	—
11	8 " .....	1.6	0.941
12	3 " fragment of seaweed .....	0.2	0.117
13	3 " " " .....	0.2	0.117
14	5 " .....	0.7	0.411
15	Fragment of seaweed .....	—	—
16	13 pebbles .....	1.5	0.882

SEA-URCHIN OF 15 MM. WEIGHING 1.7 GR. (*continued*).

17	16 pebbles .....	1.6	0.941
18	12 „ .....	1.8	1.058
2.5		0.1	1.007
			0.592

## SEA-URCHIN OF 19 MM. WEIGHING 4.3 GR.

1	2 pebbles, operculum (? of <i>Purpura</i> ) ...	0.5	0.011
2	2 „ piece of seaweed, 12 cm. long, fragment of seaweed .....	2.7	0.627
2.7		0.5	1.600
			0.319

## THREE SEA-URCHINS OF 21 MM., EACH WEIGHING 5.6 GR.\*

1	6 pebbles, empty shell of <i>Nassa</i> .....	3.5	0.625
2	1 pebble, empty shell of <i>T. cinerarius</i> .....	1.5	0.267
3	8 pebbles, empty shell of <i>Rissoa</i> .....	2.0	0.357
4	2 „ .....	—	—
5	Large mass of seaweed .....	4.0	0.714
6	4 pebbles, piece of seaweed .....	4.3	0.767
7	2 „ 2 pieces of seaweed .....	3.0	0.535
8	9 „ piece of seaweed .....	4.9	0.875
9	1 pebble .....	—	—
10	9 pebbles .....	2.8	0.500
11	10 „ empty shell of <i>Purpura</i> ...	3.5	0.625
12	1 pebble .....	—	—
13	10 pebbles .....	1.4	0.250
14	9 „ .....	1.4	0.250
15	5 „ .....	1.9	0.339
16	12 „ .....	1.6	0.285
17	2 „ .....	—	—
18	5 „ .....	0.9	0.160
19	11 „ .....	1.0	0.178
20	1 pebble .....	0.5	0.089
21	6 pebbles .....	0.8	0.142
4.9		0.5	2.294
			0.409

\* For the reasons mentioned in the footnote on p. 442, these Sea-Urchins cannot be considered separately. The same remark applies to those of 23 and 27 mm.

## THREE SEA-URCHINS OF 23 MM., EACH WEIGHING 8.0 GR.

1	9 pebbles .....	2.0	0.250
2	13 " living <i>Nassa</i> .....	4.5	0.562
3	13 " empty shell of <i>T. cinerarius</i> , Sea-Urchin of 10 mm. ....	3.5	0.437
4	1 pebble, empty shell of <i>T. cinerarius</i> .....	0.5	0.062
5	Piece of seaweed .....	1.0	0.125
6	1 pebble .....	0.3	0.037
7	Fragment of seaweed .....	—	—
8	4 pebbles .....	—	—
9	1 pebble .....	—	—
10	7 pebbles, fragment of seaweed .....	1.1	0.137
11	3 " .....	0.3	0.037
12	5 " .....	0.6	0.075
4.5		0.3	1.533
			0.191

## TWO SEA-URCHINS OF 27 MM., EACH WEIGHING 12.7 GR.

1	3 fragments of seaweed, piece of <i>Ser- tularia operculata</i> .....	0.1	0.007
2	3 pebbles .....	0.7	0.055
3	3 " .....	0.5	0.039
4	1 pebble .....	2.2	0.173
5	7 pebbles .....	2.7	0.212
6	Piece of seaweed .....	1.6	0.125
7	3 pebbles .....	0.2	0.015
8	5 " .....	2.4	0.188
9	2 " .....	0.2	0.015
10	1 pebble .....	0.2	0.015
2.7		0.1	1.080
			0.084

Certain points, some of which are clearly brought out in the foregoing records, began to appear as the investigations proceeded. The records show, for example, that the proportion between the weight of the objects carried and the weight of the body of the Sea-Urchin was much higher in the smallest individual than it was in any of the others, and (if the individual of

19 mm. is excepted\*), that there is a gradual decrease in this proportion in passing from the smallest to the largest, the series being 1.596, 0.592, 0.319, 0.409, 0.191, 0.084. They also show that objects were much more frequently picked up and carried by the smaller individuals than by the larger ones (again excepting the Sea-Urchin of 19 mm.), the number of recorded occasions on which the animals bore fresh materials during the twenty-eight days being 17, 18, 2, 7, 7, 7, 4, 4, 4, 5, and 5. Indeed, this latter difference would have been much more pronounced if it had not been that during the first eight days a source of error crept into the records; this was that the smallest Sea-Urchin, which disappeared soon after it was put into the aquarium, was found later to be really present on the floor of the tank, completely hidden by the pebbles which the animal carried. This Sea-Urchin was afterwards usually found by drawing a stick gently over the surface of the shingle, but on several mornings it could not be discovered even by this means. The individual of 15 mm. also was sometimes too well hidden to be detected. The larger ones, on the contrary, could always be seen in the first glance at the tank. Whilst the largest specimens (27 mm.) carried an average number of three objects, the smallest one (10 mm.) was almost always completely covered with an average number of nine to ten objects. The two smallest ones were very rarely found to be without objects, but the larger ones were often to be seen in this state, and the latter would sometimes allow several successive days to pass without bearing any materials.

The two small Sea-Urchins showed a very marked tendency to remain on or amongst the pebbles, the individual of 10 mm. being seen to climb up the face of a rock only eight times, and the one of 15 mm. only four times, in the thirteen weeks. The larger ones were in the habit of creeping freely all over the rocks, and upon the bottom, sides, and glass front of the aquarium.

\* This Sea-Urchin was extremely sluggish, often remaining in one place (usually near the surface of the water) for several days in succession, though it seemed quite healthy. It was only seen to carry materials on five occasions in thirteen weeks. Its behaviour was probably abnormal.



There was also a striking difference between the smaller (10 and 15 mm.) and the larger (21 to 27 mm.) individuals in the manner in which materials were picked up. The small ones would proceed quickly to substitute other objects as often as their materials were taken from them, but the larger ones either neglected to do this or performed the operation in a less determined fashion. The records of three series of experiments out of a number will serve to illustrate this point.

1. The Sea-Urchin of 10 mm. was found one morning to be almost hidden beneath the nine pebbles, weighing 1.0 gr., which it carried. After these pebbles had been removed from the animal and weighed, the Sea-Urchin was put back into the tank. During the following fifteen minutes it covered itself with twenty-one pebbles weighing 1.8 gr. Twenty-two minutes later it had again completely covered itself with fifteen pebbles weighing 1.9 gr. A third time it covered itself, with twelve pebbles weighing 1.2 gr. It repeated the action a fourth time, but the number and weight of the stones was not ascertained. On the following morning the animal was found to be carrying ten pebbles weighing 1.0 gr. Nineteen minutes after removal of these it had picked up twelve stones and a piece of seaweed weighing 2.4 gr. Nine minutes afterwards it had nearly covered itself with nine pebbles weighing 1.0 gr. Its subsequent actions on this day were not noted. It should be pointed out that on each of these occasions the animal was closely watched, and was seen deliberately to pick up the pebbles, and with its spines and tube-feet to move them slowly from place to place on its body until it was hidden. Whenever the Sea-Urchin was returned to the aquarium after examination, it was not merely dropped into the water but was placed on the floor in its natural position, mouth downwards, in order that there should be no possibility of confusing the stones which were really picked up with those to which the animal merely fastened its tube-feet in the act of turning over.

2. Further experiments were made with the Sea-Urchin of 15 mm. Eight pebbles (weight not taken) were removed from its body, and in fifteen minutes it had picked up seven pebbles. It again covered itself with ten pebbles. Next day it was found to be carrying six pebbles (weight not taken), and when these

were removed it picked up eight pebbles weighing 1.6 gr. in eighteen minutes. Its further movements were not watched on this day, but on the following morning it was found to be carrying three pebbles and a fragment of seaweed weighing 0.2 gr. It again picked up these objects whilst it was being weighed in the small vessel of sea-water. Ten minutes after being replaced in the tank it had picked up five pebbles of 0.7 gr. Two minutes after removal of these it had picked up a piece of seaweed. As in the case of the Sea-Urchin of 10 mm., this specimen was always replaced in the aquarium with its mouth downwards, and was watched as it picked up each object. The manner in which these two small Sea-Urchins picked up fresh objects suggested that removal of the materials acted as a stimulus to pick up others.

3. The five largest Sea-Urchins were placed on the floor of the tank, after removal of any objects they carried. One deliberately picked up a piece of seaweed and carried it in the course of a few minutes to the anal region. One picked up four stones and carried them to the anal region in ten minutes. One picked up one pebble and carried it to the anal region in ten minutes. The two largest picked up one of them one pebble, and the other two pebbles, but each let its burden fall again almost immediately. Next day six large Sea-Urchins were deprived of any materials they carried, placed on the floor of the tank, and watched for half an hour. During this time an individual of 23 mm. picked up seven pebbles and a piece of seaweed weighing 1.1 gr.; one of 21 mm. picked up five pebbles of 0.9 gr.; another one of 21 mm. picked up eleven pebbles of 1.0 gr.; and three of them (of 23, 27, and 27 mm.) did not pick up any objects. One of the Sea-Urchins of 27 mm., which persistently crept away to ascend the vertical side of the aquarium, was replaced on the pebbles on three successive occasions, but on none of them did it attempt to pick up anything.

The evidence derived from the observation of these eleven Sea-Urchins suggests that the habit of carrying foreign materials is gradually lost as the animal grows bigger.\* There would

\* R. Elmhirst ('The Naturalist at the Seashore,' 1913, p. 33) mentions that the Edible Sea-Urchin (*E. esculentus*) occasionally dresses itself with materials, "especially young ones."

certainly seem to be more need of protection for the smaller than for the larger individuals, because an animal which might easily manage to eat a Sea-Urchin of 10 mm. possessing comparatively small spines, might not be able to eat one of 30 or 40 mm. with a formidable mass of spines.

It was to be noted that if any objects at all were carried by a Sea-Urchin, these objects were nearly always held so that they covered the anus of the animal. This was well seen in the case of the large individuals, and was particularly striking when one of them carried only one or two pebbles. In one hundred and ten successive examinations of loaded Sea-Urchins it was found that in ninety-six cases the materials were so arranged that they covered the anus, while in the majority of the other fourteen cases they were carried close to it. It would seem that while a Sea-Urchin gradually loses the habit of carrying a mass of objects, it retains that of carrying sufficient to cover the anal parts, and this habit (observed in other examples besides these eleven) seems to demand an explanation.

When a Sea-Urchin is watched as it creeps with its load along a horizontal surface, a sufficient explanation would seem to be that the animal instinctively places the objects on the part where they are most easily carried, that is, on the flattened upper pole of the animal. But this explanation is seen to be inadequate when it is remarked that Sea-Urchins carrying materials are to be seen in a vertical position quite as often as they are in a horizontal one, and that it has several times been observed in the tank that a Sea-Urchin in a vertical position will proceed to transfer to its anus a stone laid upon the uppermost part of the animal. The true explanation may perhaps be that in the living\* Sea-Urchin the well-marked anal region, with its palisade-like circle of spines, readily catches the eye of a predatory fish, and must therefore be hidden. Again, when the Sea-Urchin is defæcating, the successive pellet-like fæces attract attention as they fall down the animal after being thrown out of the anus, and the presence of a pebble or other object (which is usually held, by the spines or tube-feet or both, at a little height

\* In a dead Sea-Urchin, owing to the irregular way in which the spines are disposed, this eye-like anal region is by no means so conspicuous as it is in the healthy living animal.

above the anus) might serve to confuse an enemy as to whence the rolling pellets came. Fishes and Starfishes seem to be the chief enemies of Sea-Urchins.\* Defence by disguise may be effective against fishes, but it would probably be of little use against the Starfishes, which find their food by scent. When a sluggish or dying Sea-Urchin is attacked by *Asterina gibbosa*, as sometimes happens in the aquarium,† the asteroid "sits" over the anus or mouth of the echinoid, and then slowly digests and breaks a way through the anus, or the membrane surrounding the mouth.‡ Two or three stones or other objects might therefore be of service to the Sea-Urchin in preventing the Starfish

\* The following are some of the published observations as to the enemies of Sea-Urchins. Rymer Jones ('The Aquarian Naturalist,' 1858, p. 203) states that small *Echini* form part of the food of the Common Starfish. Ludwig (in Bronn's 'Thier-Reichs,' Echinodermen, Buch iv. 1904, p. 1302) mentions that remains of *Echinus* have been found in the Haddock, *E. miliaris* in the Grey Gurnard and Plaice. According to Todd ("Notes on the Invertebrate Fauna and Fish-food of the Bays between the Start and Exmouth," 'Jour. Mar. Biol. Assoc.,' vol. vi. N. S., 1900-3, p. 558) remains of *Echinus* have been found in the Dab. Eichelbaum ("Über Nahrung und Ernährungsorgane von Echinodermen," 'Wissensch. Meeresunters. Kiel, N. F.,' Bd. 11, 1910, pp. 190-200) found remains of Sea-Urchins in various species of Starfishes. Schiemenz ("How do Starfishes open Oysters?," translation by Allen in 'Jour. Mar. Biol. Assoc.,' vol. iv. N. S., 1895-7, p. 268) saw a moderately large Sea-Urchin attacked by two individuals of *Asterias glacialis* in the aquarium at Naples. Franz ("Ueber die Ernährungsweise einiger Nordseefischer besonders der Scholle," 'Wiss. Meeres. Helgoland, N. F.,' vol. ix. 1910, pp. 201 and 202) found pieces of Sea-Urchins in the Wolf-fish, and *Gadus minutus*, &c.

† This was the case with the individual of 39 mm. when it was dying, and also with an individual (not belonging to the eleven) of 26 mm.

‡ I have not seen the larger Starfishes attacking a Sea-Urchin, but it is possible they would sit over the same parts. Schiemenz (*loc. cit.*) speaks of the clever way in which the two Starfishes at Naples forced their stomachs through openings which appeared little adapted for the purpose; one threw its stomach into the narrow space between spines, and the other attacked the mouth, of the Sea-Urchin. Before my observations on the Sea-Urchins were begun, I had found by experiments that if an *Asterias rubens* was given a dead fish, in whose abdomen a small opening had been made with the point of a knife, the asteroid would pass its stomach through the opening and search the interior of the fish. The asteroid would also pass its stomach through a puncture made in the abdomen of a dead Hermit-Crab.



from fixing its everted stomach tightly upon the anus of the echinoid. It may be that whilst the Sea-Urchin is able gradually to give up carrying a mass of protective or disguising materials, because the larger it grows the less liable it is to attack, it is still compelled to protect or hide one vulnerable spot.

These and other considerations gave rise to some experiments to decide (1) whether the larger Sea-Urchins would always pass objects from outlying parts of their bodies on which the objects had been laid to the anal region, and (2) the length of time taken in this transference. Some facts which bear upon these two points have already been incidentally mentioned (p. 448). In one series of experiments, made in one morning, six Sea-Urchins were used. An empty *Nassa* shell held against the periphery of a horizontal Sea-Urchin of 23 mm., just above the level of the ground, was retained by the animal and carried to the anus in four minutes. A pebble held to the periphery of a horizontal specimen of 21 mm. was grasped, carried across the upper surface of the body, and let fall on the other side in three minutes. A specimen of 23 mm., clinging to the vertical face of a rock, took a stone at the same part, passed it around the edge of its body, and dropped it, in three and a half minutes. An empty shell of *Trochus cinerarius* placed directly in front of, and about a quarter of an inch away from, a Sea-Urchin of 27 mm. advancing along a bare horizontal rock, was picked up when the animal touched it and passed over to the anus. Six and a half minutes elapsed from the moment of placing the shell to the moment it reached the anus. A Sea-Urchin of 23 mm., climbing up the vertical face of a rock, retained a pebble which was given to it, and carried the stone to the anus, in ten minutes. An empty shell of *Nassa* placed loosely upon the uppermost part of a Sea-Urchin of 27 mm., which was climbing up the vertical face of a rock, was allowed to fall. As a rule a Sea-Urchin, even if it does not want to retain an object, will pass it across its body in order to drop it, but in this instance the animal raised the uppermost part of its body, let the shell pass down between its oral surface and the face of the rock, and then, lifting the lowermost part of its body, allowed the shell to slip to the bottom of the tank. This operation took nearly two minutes. Another series of experiments was made a few days

later. A Sea-Urchin of 27 mm. was given a pebble which it carried, not quite as far as, but nearly to, the anus, where it was retained, in twelve minutes. The other individual of 27 mm. carried a pebble given to it for about half the distance between its periphery and its anus, where the stone was held, and no further progress was made during the following half hour. A Sea-Urchin of 23 mm. carried a pebble from the periphery to the anus in fifteen minutes. Flattish stones of about 5 mm. were used in the experiments. The foregoing observations seem to me to suggest that, if it is going to carry the objects at all, the Sea-Urchin deliberately directs them towards its anal region.

The chief facts recorded in this paper, and the inferences which may, I think, be fairly drawn from them, can be summarized as follows:—1. The proportion between weight of objects and weight of body is greater in the smaller than in the larger Sea-Urchins. 2. Objects are more frequently picked up by the smaller animals. 3. The smaller ones substitute objects for those which have been removed from them more certainly, quickly, and determinedly than do the larger ones. 4. The habit of carrying numerous objects is probably lost with age, but that of covering the anus is retained. 5. The objects are usually arranged so as to cover the anus, even if the other parts are left exposed. 6. The probable uses of the objects over the anus are: (a) to hide the eye-like anal region; (b) to confuse an enemy as to the place from whence the faeces issue; (c) to keep off the stomachs of Starfishes. 7. Objects picked up are usually transferred to the anus.

It formerly seemed to me to have been too readily assumed that foreign objects were picked up and carried by the Sea-Urchin for purposes of disguise. Some of the objects (such as living molluscs) even seemed likely to attract carnivores which might attack the Sea-Urchin itself, whilst others (such as one tiny pebble on a large individual) seemed to be entirely useless. Again, the peculiar locomotory organs of the Sea-Urchin had to be taken into account. These and other considerations raised the question whether the Sea-Urchin really possesses an instinct which prompts it to pick up materials which will act as a disguise, or whether the animal in creeping along, or in climbing, or in steadying itself, affixes some of its tube-feet to loose neigh-

bouring objects, and simply neglects to drop them again. It was to satisfy myself on this matter that the investigations herein described were really undertaken, and it was not until they had been in progress for some time that my attention became fixed upon the other points explained in this paper. The above-mentioned instances (pp. 447-8) in which the two small Sea-Urchins covered themselves with objects in their energetic and determined manner on several successive occasions proves that the picking up of materials is not merely accidental or incidental. There now appears to me to be little doubt that the Sea-Urchin has the instinct in question. Disguise, however, is probably not the only use of the objects. Another important use may be the resistance which they offer to fixation upon the Sea-Urchin of the everted stomach of a Starfish.

THE PHARYNGEAL TEETH OF FISHES.

By COLONEL C. E. SHEPHERD (Indian Army).

(Continued from p. 105.)

NANDIDÆ.

*Nandus marmoratus*, an Indian fish, has eight tubercle gill-rakers on the outer edge of the first cerato-hypobranchial, the eighth one from the angle being long in shape, equalling three of the others in length. The inner side of this arch has seven independent little gill-rakers. There are four on the outer side of the first epibranchial. The outer and inner sides of the second and third arches and the outer side of the fourth arch have similar gill-rakers, but rather smaller than those of the first arch. All these gill-rakers carry very minute but palpable teeth. There is a group of cardiform teeth at the junction of the second arch with the basibranchials. The upper pharyngeal teeth are in two groups on each side. They are well-defined cardiform teeth. The lower pharyngeal teeth are on two long plates and are smaller cardiform teeth than the upper.

PERCIDÆ.

*Perca fluviatilis* (the Perch) has twelve horny gill-rakers on the cerato-hypobranchial of the first arch, with three rudimentary ones at the end, and three rudimentary ones on the first epibranchial. The gill-rakers of the other arches are tubercles. The horny gill-rakers bear teeth; the length of the longest of the gill-rakers is about equal to the depth of the gill-laminæ below it. The upper pharyngeal teeth show as three distinct groups on the heads of the second, third, and fourth epibranchials of minute teeth. The lower pharyngeal teeth are on two long plates of even more minute teeth.

*Acerina cernua* (the Pope, Ruff, or Jack Ruff) has eight small tubercle gill-rakers on the cerato-hypobranchial of the first arch, with one on its epibranchial. The other arches have similar tubercles each side that fit into each other, forming a good filter apparatus. The upper pharyngeal teeth show as in three groups of minute teeth each side. The lower pharyngeal teeth are in a V-shaped group of minute cardiform teeth.



## SILLAGINIDÆ.

*Sillago sihama*, called the "Whiting" at Madras, where it is an esteemed table fish, has twelve long horny gill-rakers on the cerato-hypobranchial of the first arch, the longest nearly equal in length to the depth of the gill-laminæ below it. The inside of the first arch and both sides of the other arches have tubercle gill-rakers that fit in alternately but not very closely together; the filter they form is not a close one. The upper pharyngeal teeth are in a narrow band on the second epibranchial, and in a broad patch formed of two groups on the heads of the third and fourth epibranchials. These teeth are very minute. The lower pharyngeal teeth are in two broad triangular groups of similar minute teeth.

## CAPROIDÆ.

*Capros aper* (the Boar Fish) found occasionally on the English coast, has its upper pharyngeal teeth arranged in three distinct rows of fine cardiform teeth. They form three parallel rows. The lower pharyngeal teeth are villiform.

## OSPROMENIDÆ.

*Osphromenus olfax*, the Gourami of the Malay Archipelago, one of the most esteemed fishes for the table, has ten short, triangular-shaped, rather soft gill-rakers on the outside of the cerato-portion of the first branchial arch. Their shape is approximately equilateral, the height of the one nearest the angle of the branchial arch being one half the depth of the gill-laminæ below it. The inner side of the first arch, both sides of the other gill-bearing arches, and the outer side of the fifth arch are covered with numerous soft gill-rakers that fit closely into each other from opposite sides, forming a perfect filter apparatus. The upper pharyngeal teeth are in two groups each side, the upper one crescentic, the lower circular in shape; they are separated by a broad band of mucous membrane. The teeth show as little black-brown specks, and are cardiform. The lower pharyngeal teeth are in a broad band right across the mouth, are likewise blackish, cardiform, and rather sparsely spread about. The lower pharyngeal bones are separate.

*Osphromenus trichopterus*, also from the Malay Archipelago, has a large number of soft, small gill-rakers so close together as not to admit of being accurately counted; they appear to form a

narrow ribbon on the edges of the branchial arches, and fit so closely as to make a very efficient filter. The upper pharyngeal teeth are represented by two soft circular patches of concentric circular corrugations round a central nucleus of papillæ. The plan of the lower pharyngeal teeth is occupied by soft papillæ.

#### EMBIOTOCIDÆ.

A family of viviparous fishes frequenting the North Pacific Ocean.

*Neoditrema ransonettii*, a fish from Japan, has sixteen horny gill-rakers on the cerato-hypo of the first branchial arch, the longest of these about two-thirds of the depth of the gill-laminæ below it; there are six similar ones on the first epibranchial. Those on the cerato-hypo portion bend over in the forward direction, and have soft bristle-like projections on them. The other arches have tubercular gill-rakers that fit in from opposite sides and make a close filter. The upper pharyngeal teeth are in two groups, one each side, of strong conical teeth set close together. The lower pharyngeal teeth are in a triangular group, set across the floor of the gullet, of similar teeth, the row nearest the œsophagus being rather larger than the others. The lower pharyngeal bones are united. (See fig. I., 1, which has been enlarged to twice the natural size to show the teeth more clearly). The top of the gullet has been divided, and folded sideways each side, to enable the lower pharyngeal teeth to be more clearly seen. This had to be done also with the illustration of the pharyngeal teeth of the *Labridæ*.\* The similarity in the pharyngeal dentition would point to a similar molluscan and crustacean diet.

*Hysterocarpus traski*, a fish from California, has eight horny, moderate-sized gill-rakers on the first cerato-hypobranchial arch, and seven on the epibranchial. The length of the longest is about half the depth of the gill-laminæ below it. The inner side of the first, and both sides of the second, third, and fourth arches are set with tubercle gill-rakers that fit in from opposite sides and form a close filter. The upper pharyngeal teeth show as a roughly circular group, on each side, of conical teeth with some in their middle of a rounded granular shape, possibly due to their being more ground down; they are the largest in the

\* See 'Zoologist,' December, 1911, p. 454.

group. The lower pharyngeal bones are united, and carry a group of pavement-like teeth; at the back and in the middle they are of large size and show marks of grinding action; on the outer sides of the middle ones and coming towards the apex of the triangle are smaller conical teeth (fig. I., 2).

*Ditrema temminckii*, a fish from Tokyo, Japan, has twelve long horny gill-rakers with small bristles on their inside edge; three are rudimentary ones, all on the cerato-hypo portion of the first branchial arch with six on the epibranchial. The length of



FIG. I.

NEODITREMA RANSONETTII. DITREMA TEMMINCKII. HYSTEROCARPUS TRASKI.

the longest one equals the depth of the gill-laminae below it. The other arches have tubercle gill-rakers fitting closely and making a good filter. The upper pharyngeal teeth consist of a small row of soft bristles on the head of the second epibranchial, and a roughly circular plate of strong conical teeth set closely together on the heads of the third and fourth epibranchials. The lower pharyngeal bones are united and carry a triangular group of conical teeth set very closely together, small at the front apex and getting larger posteriorly, the last row being comparatively large (fig. I., 3).

(To be continued.)

THE RELATION OF THE OYSTERCATCHER TO ITS  
NATURAL ENVIRONMENT.

BY J. M. DEWAR, M.D.

(Concluded from p. 431.)

## VIII.—THE OPTIMUM HABITAT IN WINTER.

On the south side of the Firth of Forth three areas carry large stocks of Oystercatchers. These areas are chiefly, or entirely, mud-flat habitats. The remaining four areas, coming under observation, are rock-beach habitats, and they carry small stocks. As it has not been possible to determine the total quantity of Mussels available in each area, and as periodic estimations of the numbers in each stock, excepting those of the small stocks, proved disappointingly variable, the direct method of comparing the numbers of the birds with the size of the *Mytilus* areas, where they feed, could not be used. Recourse was had to other means.

I have elsewhere \* stated, from fairly extended observations, that the Oystercatcher is unable to open tightly-shut Mussels, unless it can reach the byssal cleft, or the Mussels are small enough to be crushed. The former possibility occurs infrequently, Mussels opened through the straight border forming only nine per cent. of the opened shells examined. The latter is apparently avoided, whenever possible, and the birds reject Mussel-flesh mixed with fragments of shell. Dryness of the surroundings brings about a tight closure of the shells, and follows shortly after the tide has receded from the scalps. The birds are then confined in their search to the tide-line, pools, under seaweed, and under mud near the scalps; a hunt for Mussels presenting the straight border, and the hammering of small Mussels being evidently the last resort. Mussels that become covered with mud are soon killed, and are never numerous; their presence under seaweed is accidental; while *Mytilus* is predominantly not a pool-dwelling form in the littoral zone. The principal search must, therefore, be confined to the margin of the tide.

From these considerations it is evident that the ultimate bearing capacity of a *Mytilus* station is directly determined by

\* 'Zoologist,' 1908, p. 201; 1913, p. 41.



the quantity of Mussels available in the water margin during successive phases of the tide, and not by the total number of Mussels on the station ; and that, other things being equal, the longer, that is, the more sinuous the contour lines, and the more shallow the gradients of the station—the greater the number of Oystercatchers a given area will support. These requirements are fulfilled better by the mud-flat than by the rock-beach habitat. In the former, the presence of banks and the extreme shallowness of the gradients cause a comparatively large area of the Mussel-scalp to be kept in a moist condition at all states of the tide within the *Mytilus* zone. As a result, the birds have not only a long contour line along which they can extend, but also, owing to the great breadth of shallow water, they can work over a greater area, and in several rows, or even in masses. In general, contrary conditions prevail on the rock-beach. The greater steepness of the gradients and the shortness of the contour lines narrow and reduce the length of the zone available at a given time, so that it is unusual to observe the birds in more than single file in the tide-line, after drying of the exposed Mussels. Other circumstances favour the mud-flat habitat. The Mussels run to larger sizes than on the rock-beach, and provide a greater proportion of those sizes most usually taken by the Oystercatcher. The exposure to the effect of storms is negligible on the mud-flat. Wave-action here does not interrupt the operations of the birds. The rock-beach has mostly a great, or severe, exposure to storms, and in bad weather, which in winter may last for days, wave-action interferes with search in the tide-line, and in some places may render whole feeding-grounds entirely inaccessible. Exposure of the rock-beach to severe wave-action is a necessity for the existence of *Mytilus*, for wherever the rocks occupy sheltered positions, the growth of weed is excessive and Mussels are absent. The mud-flat habitat is not drawn upon by Diving Ducks, which devour large quantities of Mussels on the rock-beach habitat ; there being here a different time-distribution in the community, the Ducks operating towards high water and the Oystercatcher towards low water on the same feeding-grounds. Owing to the great area exposed on the ebb and the uniformity of the surface, the mud-flat is more favourable to the Oystercatcher in regard to human in-

trusion. The rock-beach, even when it takes the form of skerries, has less depth of foreshore, and a variety of surface features, which, in some places, are a direct assistance to human approach.

On these grounds the mud-flat is regarded as an optimum habitat of the Oystercatcher, on the south shore of the Firth of Forth, in so far as food activities are concerned. It is obvious, however, that a mud-flat will not form an optimum habitat in a district having a large human population, unless it has attached to it a place of refuge, available during high water and at other times, when the feeding-grounds are disturbed. There are other non-essential conditions of which one—the wet sand-beach—has been definitely recognized.

In more general terms, the conditions of an optimum habitat in winter are: (1) a body of sea-water; (2) edible Mussels in sufficient quantity and of a suitable size (mostly not under 2.5 cm. in length), stationed on an area which has shallow gradients and sinuous contour lines, and which is not exposed to severe wave-action; (3) areas of soft wet sand near to the feeding-grounds, attractive in connection with the crowding and other reactions. Wherever the presence of man makes itself felt, there fall to be added: (4) separation of the feeding-grounds from the nearest potential source of danger by a distance of, at least, 150 metres; and (5) a place of refuge which is not too far away, and affords a considerable amount of security during the period of high water, and in the event of human disturbance of the feeding-grounds.

In the Firth of Forth, the large human population of its banks is, on the whole, adverse to the Oystercatcher as a species. Extensive feeding-grounds exist on both shores, which are seldom visited, and which, as far as can be seen, would adequately support a larger stock of birds than that, at present, inhabiting the whole estuary. The destruction wrought each winter on the resident stocks is so slight as to be imperceptible in the mass. This fortunate circumstance is solely due to the fact that the territories, which are inhabited, provide the conditions which make it very difficult to bring the birds within range of the gun.

#### IX.—THE OPTIMUM HABITAT IN SUMMER.

About fifty pairs are estimated to breed yearly in the lower reach of the Tummel between Pitlochry and Ballinluig. For

the 9.5 kilometres of river this gives one pair per 190 metres. On the Garry between Blair and Killiecrankie, the number of pairs is more difficult to estimate, on account of the locally abnormal habits already mentioned. It is believed to be about ten in the 4 kilometres of river, and is equivalent to one pair per 400 metres. The south side and east end of Loch Tummel are occupied by eight to ten pairs (nine in 1912), equal to one pair per 490 metres. The number of pairs found yearly in the 2 kilometres long, tree-stump area in Glen Fender is three—that is, one pair per 670 metres. On the 3.2 kilometres of the River Orchy between Loch Tulla and the bridge, two pairs are stationed (1909, 1910), being equal to one pair per 1600 metres.

The River Orchy is a fairly large river with large areas of light grey shingle. The glen is open and is occupied by a very small human population. The soil is inferior and suitable only for sheep-pasture. There is little cultivation. The birds, therefore, have to depend on the river banks and the hillside for their feeding-grounds. The supply of worms and larvæ is not so plentiful as it is on the Tummel.

The hill-stream habitat comes next in an ascending order. Its low grade value is probably due to elevation above sea-level (230–305 metres), which certainly restricts the area under cultivation, and probably affects the supply of worms and larvæ as well. The local feeding-ground comes within the normal range of the Curlew, and much of the area being marshy, there is also a large number of Snipe. Both of these birds compete with the Oystercatcher in the subterranean ground stratum of the local feeding-ground. The hill-stream habitat is peculiar in the sense that it owes its occupation by the Oystercatcher, not, it would appear, to the presence of the Fender Burn and other common elements of an occupied station, but to the large number of bleached tree-stumps scattered over the local feeding-ground. The young assimilate in colour to these stumps, which are frequently associated with the crouching response. The stumps also contribute to the food supply. The area has great breadth, and the shingle-beds in the burn course are small. The young are led much greater distances away from the shingle than is usual in other stations, and the reason which makes this possible appears to be, the tree-stumps afford protection to the young,

which especially as they grow older, seldom retreat to the shingle in the event of human or other intrusion. A later stage of the same kind of area is seen on the Cragan Dubh alluvial cone on the south side of Loch Tummel. Here the local feeding-ground on the cone is dotted over with mossy hillocks, under which, and completely covered by the vegetation, are very ancient stumps of trees. The station continues to be occupied yearly by a pair of birds, and young are usually reared, but the old tree-remains have no evident biological significance to either old or young of the Oystercatcher. The Cragan Dubh cone, though small, is a comparatively rich area, and the young do not need to be led far. The wide range of the young in the Fender area appears to be due to relative poverty of the food supply, and is undoubtedly rendered possible by the protective value of the tree-stumps. When these are covered over by vegetation at a future date, a change may be expected in the distribution or range of the birds.

Next in the sequence comes the lake-beach habitat, as represented by the south shore of Loch Tummel. The conditions here are, on the whole, favourable to the occupants and to the rearing of the young, but the size of the population is evidently controlled by two factors, of which one is the relative narrowness of the shingle beaches which are not greatly favourable, on that account, to the concealment of the eggs or the young, and the other is the limitation of the local feeding-grounds to the discontinuous alluvial cones, for suitable local feeding-grounds do not occur elsewhere.

The portions of the Garry and Tummel under observation have a higher population per kilometre than any of the other areas. In this respect they show a pronounced difference from the other representative of a river-valley habitat, already described. Using a salient and ecologically important feature, it is, therefore, proposed to distinguish a river-valley habitat, such as the Orchy, from a drift-river-valley habitat, of which the lower reaches of the Garry and Tummel are representatives. In these areas the drift, or boulder-clay, covers a large part of the ground, and is largely cultivated. With the drift, as of importance for the Oystercatcher, must be associated the large deposits of alluvium which determines the distribution and area of the



local feeding-grounds. The drift and the alluvium are more favourable to the existence of the animals on which the Oystercatcher feeds, than the poor soil of the denuded river-valley. Cultivation follows the distribution of the drift and further increases the food-supply. But cultivation means human occupation, which is generally destructive. Cultivation, therefore, operates in two opposite directions in controlling the ratio of Oystercatcher population. Cultivation tends to increase the numbers of the stock an area may carry, and, at the same time, it is constantly tending to reduce the stock by means of human interference. Evidently, a balance has been struck, as the Oystercatcher population shows little or no change from year to year. The ratio of stock on the Garry to that on the Tummel is about 1:2. The most evident differences between the two areas are the smaller size of the Garry and its shingle areas, and the larger agricultural population. The smaller shingle-beds on the Garry are less favourable to the safety of the eggs and young than is the case on the Tummel. But, even on the large shingle areas at Moulinearn and Ballinluig, there is seen a tendency to desert the shingle for the river-bank, and the connection between this phenomenon and human interference is well established. Nesting in unusual places is general in the Vale of Atholl, but it must be fairly successful, as no diminution in the local stock has been recognized. Here the abnormal behaviour is probably connected with the semi-public character of the shingle and the large human population, the Vale of Atholl being the most populous district in the area under observation. It would appear as if, under the present secondary conditions of the river-valley, a too large human population outweighs the advantages which drift, and cultivation by a moderate population, confer upon the Oystercatcher.

Owing to the erratic nesting behaviour in the Vale of Atholl no reasonably complete figures could be obtained for the ratio of families to nests, and hence no comparison of the breeding results in the Garry area with those on the Tummel is possible. The results obtained at Loch Tummel, however, show that the relatively moderate stock on the south shore of Loch Tummel, as compared with the relatively large stock carried by the lower part of the river Tummel, is not due to greater difficulties in rearing young.

In 1912, nine pairs on the south shore and the storm beach of Loch Tummel produced four families of altogether nine young. In 1914, eight pairs produced three families of  $4 + X$  young (probably seven). On the river Tummel, in 1909, at Moulinearn, eleven pairs had five families of eleven young. On the Logierait, upper island station, in 1910, ten pairs had four families of eight young, and in 1912 eight pairs had three families of six young. The ratios of adults to young in the two habitats are, therefore, approximately similar, being about 2.2 : 1. These two habitats are equivalent in human population and in amount of human intrusion in the territories. But the ratio of stocks in the two areas is relatively high, being as 2.5 on the river to 1 on the loch. The control of the Oystercatcher population in the two areas must, therefore, be sought in the factors already given, namely, the size and distribution of the shingle areas, alluvium, and boulder-clay. These three factors are equivalent on the Garry and the Tummel, except in total area. The size of the total area, when continuous as it is on these rivers, ought not to affect the linear distribution of the birds. The cause of the lesser population per kilometre in the Vale of Atholl may, therefore, with a fair degree of probability, be referred to the greater human population.

Thus, on the basis of population ratio and other considerations already mentioned, the drift-river-valley may be regarded as an optimum habitat in summer, within the area placed under observation. In some, the prevailing conditions of an optimum habitat in summer are :—(1) A breeding area and refuge, of sufficient extent, close to a body of water, rising well above summer flood level, devoid of vegetation, assimilating in colour appearance to the eggs and more especially the young, and fairly secure from human and other enemies.

(2) A local feeding-ground of sufficient area, to which the young have access on foot, terraced to form two adjacent levels so that, when the birds are on one level, they cannot readily be seen by an enemy from the other, covered with old turf, rich in tipulid and coleopterous larvæ, together with at least a moderate supply of earthworms, and fenced in, or in other ways protected from disturbance; both the breeding area and the local feeding-ground being held as territories, and situated on that account not too near the habitual stations of "barren pairs."

(3) A distant or general feeding-ground resting on boulder-clay or alluvium, and preferably cultivated, to which the adults may resort for food, and from which they may bring a large supply of large earthworms to the young. Auxillary conditions which have some value are :

(4) The presence of a wet sand-beach in some part of the breeding territory ; and

(5) An abundance of Stonefly nymphs, along the river margin, at the time when most of the young Oystercatchers escape from the eggs.

#### RESUMÉ AND CONCLUSION.

The general results of the inquiry point to the mud-flat in winter, and the drift-river-valley in summer as optimum habitats within the areas under observation. The presence of a large human population has a pronounced effect on the distribution and numbers of the Oystercatcher. The Law of Territory is shown to be valid for the Oystercatcher, both in winter and in summer. The arrangement and extent of the territories, and the general movements of the birds therein, remain the same year after year. The theory of the biological advantage, or necessity of conserving the food-supply for the exclusive use of the settlement, by the maintenance of territorial rights, is supported by observations made at one winter station, where the food-activities of the settlement were found to strain the reproductive powers of the shellfish of the area. In relation to climatic conditions certain activities, normally successful, become ill-regulated when they are elicited at an abnormal period. The intangible associational barriers of Grinnell prove to be fully applied to the Oystercatcher, both in winter and in summer. They are (1) kind of food-supply afforded ; (2) presence of safe breeding-places, and (3) presence of places of temporary refuge for individuals, when hard pressed by predatory enemies.\* The last condition, though long known, had not previously been given the formal position its importance deserves among the factors of distribution. In summer for the young, and in winter for the settlements of the Oystercatcher, places of refuge are an important factor controlling distribution in the areas under observation.

\* Amer. Nat. 1914, vol. 48, p. 252.

## NOTES AND QUERIES.

## MAMMALIA.

**Whale on the Lincolnshire Coast in the Seventeenth Century.**—It will no doubt be generally agreed that all notes in non-zoological literature of occurrences of cetaceans on or off the coasts of the British Isles ought to be reproduced, for future reference, into the pages of the 'Zoologist'; and I therefore offer the following quotation from a letter dated "March 25, 1692-3," and signed "Westmorland," the writer being probably Rachel, wife of Sir Vere Fane who became fourth Earl of Westmorland. The letter is published in full in 'The Ancestor,' xi. (Oct. 1904), p. 150:—"Thare is a great whale com a shore in lincornshire of a prodidous bigth so that a man of six feet hiy may stand uprite in his mouth & it is sold for a thousan pound." Of course no Whale ever yet calved was of such "a prodidous bigth" that a man six feet "hiy" could stand upright in its mouth, but if we for the moment ignore the palate and all the contents of the enormous head above it, a large Sperm Whale might be suggestive of the possibility. The next choice would lie with a Greenland Right Whale, but as this species has never been known to move far from the ice, it may safely be assumed that no example ever came ashore in Lincolnshire. The Nordkaper or Biscayan Right Whale comes a bad third, and the Rorquals nowhere. So there can be little doubt that this Whale was a Sperm. The late Mr. T. Southwell gives several instances of its occurrence on the British coasts in his 'Seals and Whales of the British Seas,' and several have been killed during the last few years by the Finwhalers working off the Shetland coast; but of course it is very far less numerous now than it was one, two, or more centuries ago. The large sum for which the carcass is said to have been sold (and representing an even larger amount at the present value of money), though it may well be an exaggeration, would certainly indicate either a Sperm or a Right Whale; the biggest Blue Rorqual would not have fetched nearly so much.—ALFRED HENEAGE COCKS (Poynetts, Skirmett, near Henley-on-Thames).

## AVES.

**Rough-legged Buzzard in Suffolk.**—Driving along the road at Friston, Suffolk, on November 4th, I had the great pleasure of seeing



and watching for a short time a couple of these fine birds on the wing. They were, too, at no great distance, and one of them came down so low that the light-coloured plumage and white tail-coverts were plainly visible. Their flight was magnificent, as, with their long wings at full stretch, they were sailing grandly in large circles, above some ground thinly covered with young trees. It has long become a rare treat to see here in East Suffolk any large raptorial bird on the wing, and the pleasure of doing so is always damped by the knowledge that it will in all probability soon be rotting in some "gamekeeper's museum."—G. T. ROPE (Blaxhall, Suffolk).

**Norfolk Plover** (*Ædicnemus crepitans*) in Suffolk in November.—About the middle of November a Norfolk Plover was brought to my brother by a man whose dog had caught it in a hedge at Little Glemham, Suffolk. It had a broken leg, and was otherwise badly injured, having probably been disabled by a shot, and not picked up at the time. It was found necessary to destroy it on account of its crippled state. A few of these birds had occasionally been noticed by my brother in former years during the summer about some large open fields not far from his house.—G. T. ROPE.

**Grey Shrike in Suffolk.**—On November 13th I had a good view of one of these birds in a sandy lane near Blaxhall Heath. It alighted close to me on the top of a hedge soon after sunset, remaining long enough for me to get my glass to bear upon it. This spot is in summer rather a favourite haunt of the Red-backed Shrike.—G. T. ROPE.

**Black Redstart in Cambridgeshire.**—Whilst my son and I were on a visit to Cambridge on November 13th, we noticed a Black Redstart (*Ruticilla titys*) haunting the masonry on the west side of St. John's College. It was comparatively tame and frequently flew down to the ground within some thirty yards distant from where we stood. From its plumage it was probably an immature bird of the year.—J. STEELE ELLIOTT (Dowles Manor, Salop).

**Late Nesting of the Swallow.**—Cases of House-Martins with young in the nest as late as October very frequently occur, but I have never previously met with an instance of this with Swallows so late in the year. My friend Mr. R. Chase drew my attention to a nest in an outbuilding to his house at Bewdley, where the young still remained on the evening of October 10th. At this date practically all House-Martins and Swallows had left this neighbourhood, but a few of both species lingered on to October 16th, and an adult

and young Swallow were last seen on October 22nd, which were probably two of the above-mentioned birds.—J. STEELE ELLIOTT.

**Occurrence of a Reeve (*Machetes pugnax*) in Staffordshire.**—On October 30th, 1915, an adult Reeve was shot on the Sewage Farm, Leek, Staffordshire, by Mr. T. Whittles, and is being preserved for the collection of Sir Vauncey Harpur Crewe, Bart. Former records of this species in the county are:—Two in immature plumage were shot near Burton-on-Trent in 1857 (Sir Oswald Mosley's 'Natural History of Tutbury,' p. 106); one at Norton Pool, Chasetown, July 10th, 1897, an adult male ('North Staffs Field Club Report,' 1910, p. 100); and one, a young Ruff, shot near Stafford, August 29th, 1910 ('N. S. F. C. Rept.,' 1911, p. 75).—JOHN R. B. MASEFIELD (Rosehill, Cheadle, Staffordshire).

**Bird-Notes from Cardiff in 1915.—**

*March* 6th.—Pair of Magpies and a Barn-Owl seen.

27th.—Barn-Owl, Kestrel, and Heron seen near St. George's.

*April* 5th.—Moorhen's nest with seven eggs on Peterston Moors.

10th.—Lapwings' eggs found.

17th.—Magpie's nest with three eggs at St-y-Nyll, and a Carrion-Crow's nest with six eggs at St. George's. Heron seen.

24th.—Snipe breeding near St-y-Nyll, two eggs being found. Owl's nest with two eggs at St. George's.

27th.—Cuckoo heard.

*May* 1st.—Several pairs of Snipe breeding near Stockland. Six Kestrels' eggs in a Crow's nest. Swift seen.

2nd.—Redstart's nest with two eggs near Radyr. One more Owl's egg at St. George's.

6th.—Corn-Crake heard.

8th.—Young Magpies.

13th.—Saw a cock Pheasant attacked by a pair of Lapwings, evidently because it approached too near their young.

15th.—Cuckoo's egg in a Hedge-Sparrow's nest.

22nd.—Heron seen.

25th.—One Oystercatcher's egg found on Sully Island.

27th.—Four young Barn-Owls at Fairwater.

31st.—Sparrow-Hawk seen.

*June* 6th.—Young Sedge-Warblers.

13th.—Five more Owl's eggs at St. George's, making altogether a clutch of eight.

20th.—Two pairs of Red-backed Shrikes breeding within a few

yards of one another near Radyr Chain. Lesser Whitethroat's nest with four eggs.

27th.—Herring-Gull's nest on Sully Island.

July 10th.—Found Kingfisher's nest with eight eggs.

13th.—Saw a Common Sandpiper at the furze.

27th.—Owl seen. I also saw one on 2nd and 21st of this month.

August 1st.—Hawfinch seen in St. Fagan's Park.

14th.—Several Reed-Buntings noted near Glan Ely. Young Kingfisher seen.

October 2nd.—Saw a Grey Wagtail.

November 10th.—Several Marsh Tits seen near St. Lytham.

December 5th.—Lesser Spotted Woodpecker seen in the field adjoining the weir at Llandaff, and close to the spot where I found a pair breeding a few years ago.—J. S. BLAKE (59, Llanfair Road, Cardiff).

**Variations in Wood-Pigeon.**—This spring I bought at a poulterer's at Forest Hill, S.E., a variety of the Wood-Pigeon (*Columba palumbus*) with the primary quills and the tail silver-grey, the latter crossed by numerous narrow indistinct dark grey bands in the place of the broad black terminal bar. Some years ago I got a close view at the Zoo of a specimen in which this bar was replaced by a silver-grey one, and one wing showed a patch of this hue. I have also seen in Regent's Park on two occasions a bird with one conspicuous white feather in one wing—a large covert, or one of the innermost secondaries; and in St. James's Park one with the neck-patch wanting on one side and only about half the normal size on the other. This was adult, but rather small, and short in the bill.—F. FINN.

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## NOTICES OF NEW BOOKS.

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*Vigour and Heredity.* By J. L. BONHOTE, M.A., F.L.S., F.Z.S.  
London: West, Newman & Co. 1915. 10s. 6d. net.

MR. BONHOTE is one of the zoologists—a very small number at present unfortunately—who specially concern themselves with the experimental study of animal life, and he brings to this pursuit that natural liking for keeping animals which is indispensable to successful results; he is, in fact, a scientific fancier,

and the details of management he gives with regard to the keeping of such different creatures as Rats and Ducks are just what we should expect of him. His range of experimental work is wide; either alone or with the help of friends he has bred and studied not only the above-mentioned animals, but Dogs, Cats, Pigeons, and African Desert-Mice (*Meriones*). Details of these experiments are very full, and his book becomes one of those indispensable for all students of heredity, for, although many of the results have appeared in papers in scientific publications, it is important to have them collected; and the author's discussion of rival theories is full and fair. The illustrations are full and good; three of them, representing some of the multiple hybrid Ducks for which this experimenter is well known, being in colour, while it may be mentioned incidentally that the book is of handy size and well printed on a good paper. Mr. Bonhote's conception of vigour in animals is that it is comparable to "steam in a boiler that must express itself in some form of energy, and the higher the pressure the greater the energy. Nature has several safety valves; the chief and the one first used is outward expression in colour, or in restless energy (song, emigration, exercise, intellect, play, &c.); these, however, are minor outlets. If, in spite of these, the vigour still rises, sexual intercourse takes place, and the vigour of the resulting young is, if we may so express it, analogous to the steam pressure in the second cylinder." The characters of the young will depend on the vigour of the parents at the time of mating, and many very interesting instances of this are given in the experimental details, which also tend to discredit Mendelism as an universal explanation of the facts of inheritance. The notion of sex-developments as a safety-valve was enunciated rather fancifully by J. G. Wood many years ago, and we are glad to find so up-to-date an investigator as Mr. Bonhote scientifically confirms him.

Where our author deals with non-experimental evidence, he at times shows, like many zoologists even nowadays, a tendency to make too-sweeping statements, as, for instance, where he credits all Arctic animals, whose vigour he considers low, with a want of very marked sexual differences, quite overlooking the very conspicuous ones found in the Narhwal, Harp-Seal, Bladdernose, and the Long-tailed and Eider Ducks.



*The Auk*. Vol. xxxii. Nos. 3 and 4. American Ornithologists' Union, Cambridge, Mass. July and October, 1915. 75 cents each.

THE last of these two numbers of this quarterly journal of American ornithology completes the volume and contains the index, and some interesting papers and notes. Conspicuous among these are Mr. Outram Bangs's "Notes on Dichromatic Herons and Hawks," in which he, rightly in our opinion, pleads for the suppression as species of some of the various white or rufous phases of well-known forms which have been allowed specific rank in the past, such as the Great White Heron of Florida, which accumulated evidence shows to breed freely with coloured forms; and Mr. C. E. Johnson's very complete and careful study of what he calls a four-winged Wild Duck—the precise species is the Green-winged Teal (*Nettion carolinense*) which is hardly more than a subspecies of our familiar little bird. The subject was a female, and "had no difficulty in flying, but was peculiar from the fact that it flew out from some thick grass bordering a small creek back in the woods," and had failed to migrate with the rest of its species. The supernumerary wings sprang from the under side of the true wings at the region of the elbow; they were dwarfed and without quills, their covering being of the character of under wing-coverts.

In the July number there is an admirable paper on the Rock-Dove, which Dr. C. W. Townsend, the author, calls *Columba domestica*, which name, according to Stejneger, must replace *C. livia* for the familiar Blue Rock! This bird, it seems, has become feral in American cities as well as in Europe, having, of course, been originally introduced in a domestic state. In America there has evidently been a much more complete reversion to the typical colour than here, because Dr. Townsend finds the blue rock colouration the dominant one, which it certainly is not in London at all events, or in any English town we know of. Blue birds were, however, also dominant in Calcutta in our time, but here there may have been an intermixture with the Eastern race of the Rock-Dove (*C. intermedia*), which in India frequents inhabited places as well as rocky wilds. Albinism seems more common in feral American Pigeons than in English ones, but appears to be eliminated by Hawks in country places.

*British Birds.* By A. THORBURN. Vol. II. London: Longmans, Green & Co. 1915. £1 11s. 6d.

IN this volume of his magnificent work Mr. Thorburn finishes off the Crows and deals with the Larks, the Swifts, Cuckoos, &c., the birds of prey, the Cormorant and Gannet, and most of the Heron family. With regard to his treatment of these birds, both as regards the pictures and the letterpress, we must accord, as a rule, the same praise to it as we did to his first volume reviewed in the 'Zoologist' last April. Of course, as the birds dealt with in the present volume are so much more picturesque than most of the Passerines, one expects the illustrations to be more imposing than those in the first volume, and this is generally the case. The figures of the Golden Eagle and the Eagle-Owl, which occupy respectively whole pages, are well worth framing as pictures, especially the latter, which is the finest plate in the book in our opinion. In some cases the illustrations are not quite happy; the attitude of the Roller is far too Jay-like, this bird having more the pose of the Spotted Flycatcher when perched; and the Bee-eater figure has a serious mistake in it, the foot being drawn like a Swallow's, whereas it resembles that of the Kingfisher, with joined front toes and comparatively short hinder ones.

The Herons are a beautiful group, but the Cormorants are less good; artists do not seem to realize the essential picturesqueness of these weird, old-world-looking birds. The Cuckoo is presented to us as calling with the bill closed, but this, Mr. Thorburn assures us, he knows to be correct from personal observation, his attention having first been drawn to the point by Wolf many years ago.

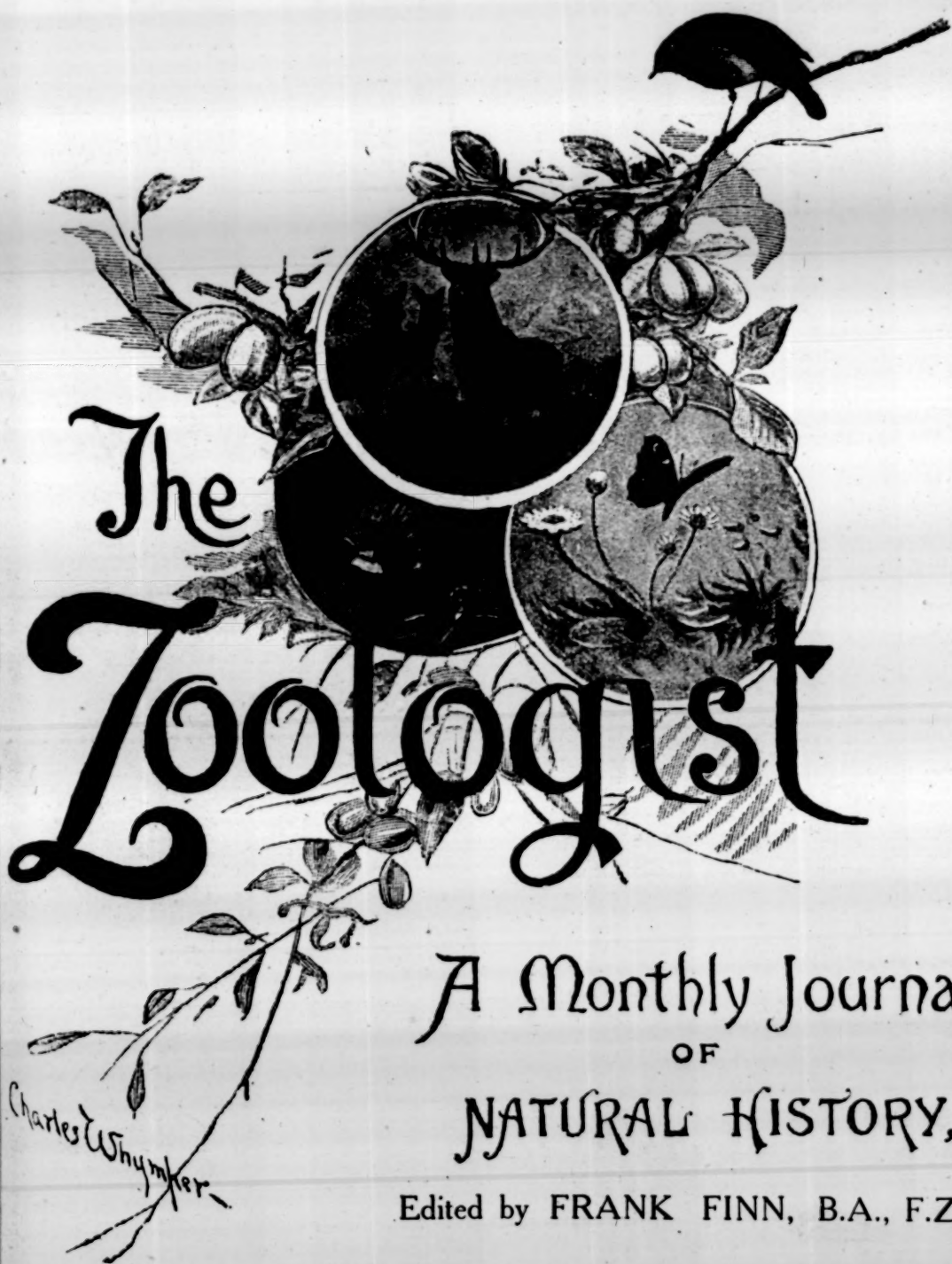
A very interesting point noted is Mr. Thorburn's observation that a melanistic Montagu's Harrier in Lord Lilford's possession had the iris dark like a Falcon's; such correspondence of iris with plumage-colour in dark varieties not being by any means universal, black fowls usually having normal eyes, and black Pigeons always normal or even light ones.



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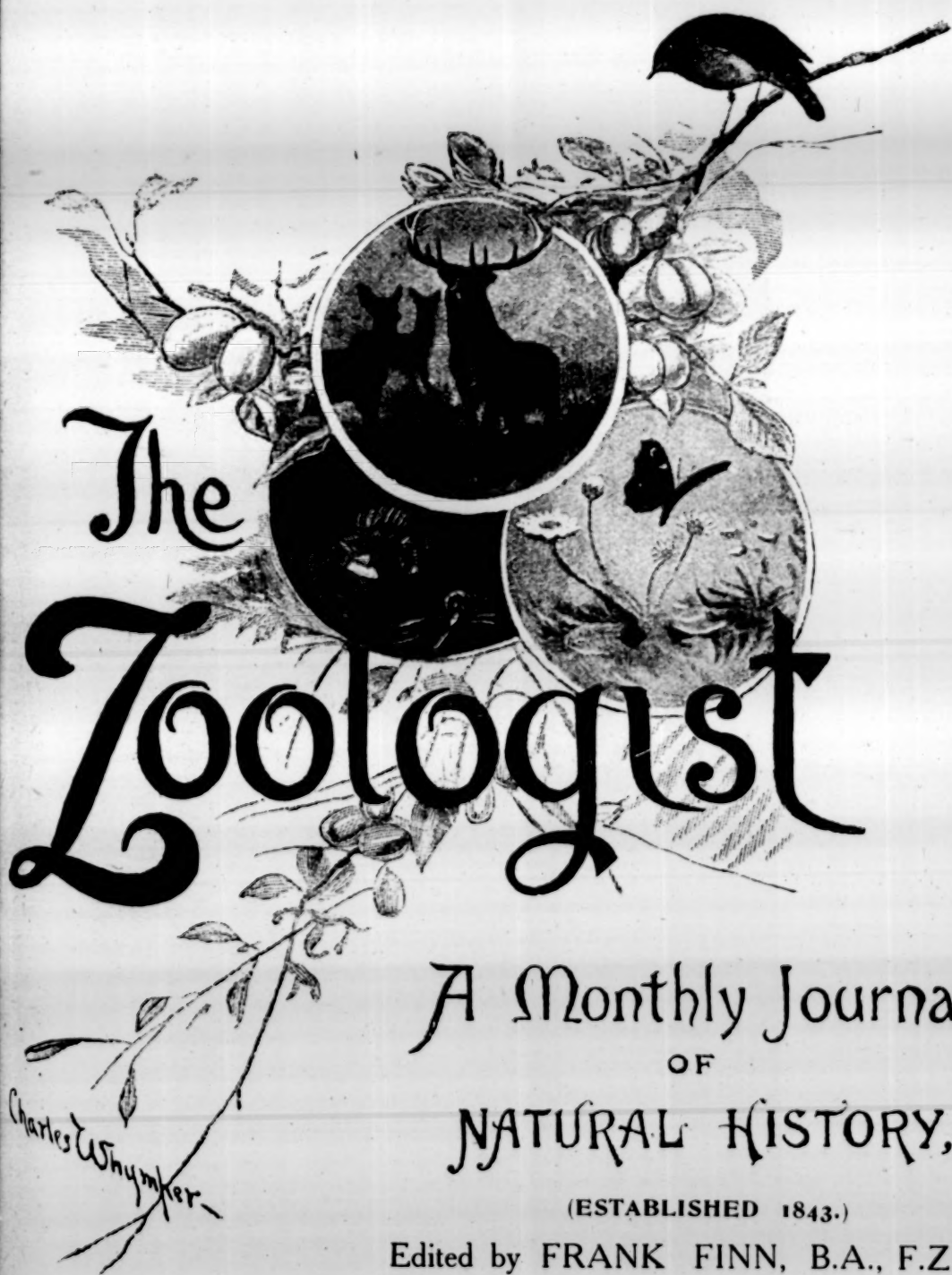
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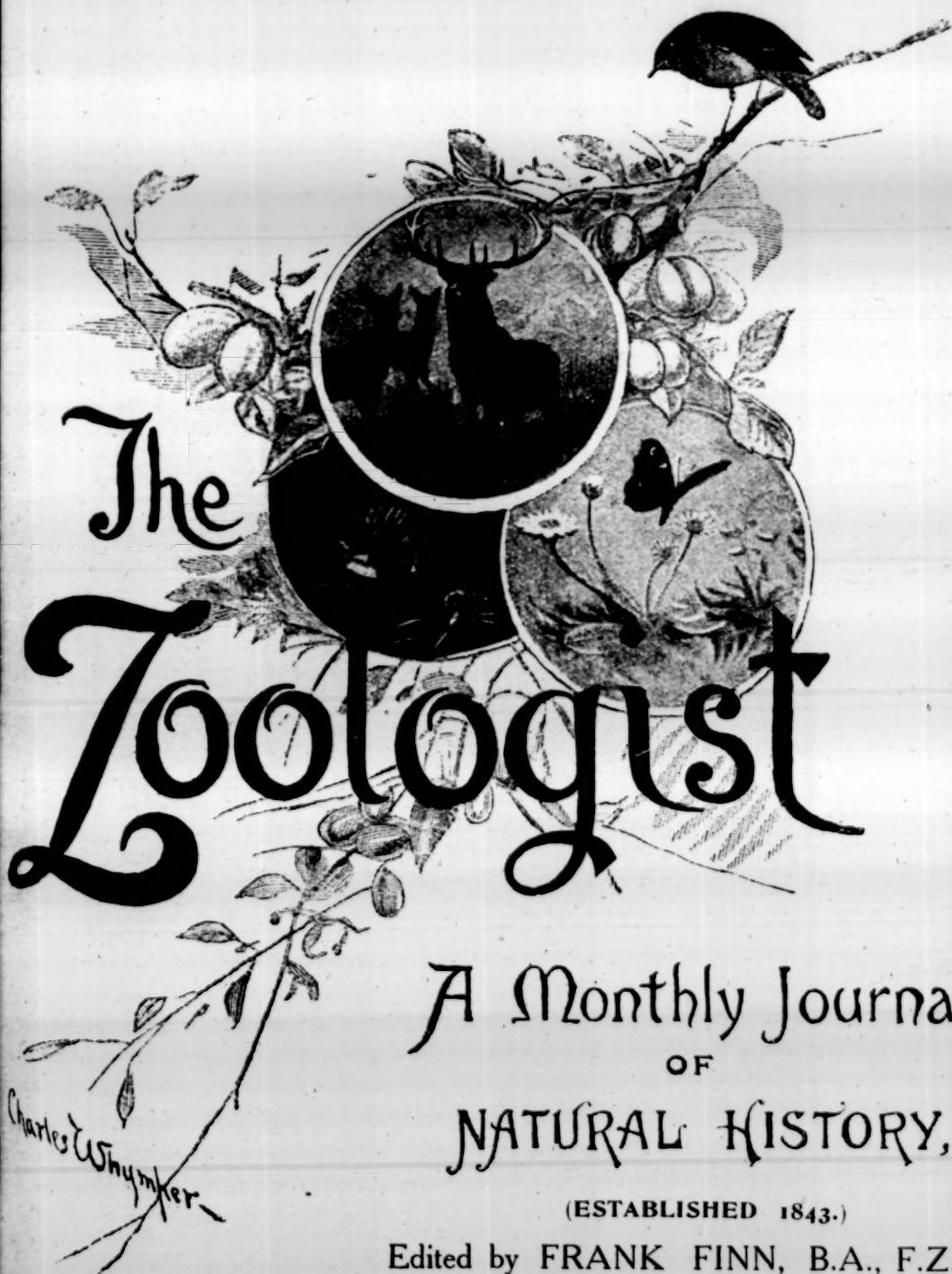
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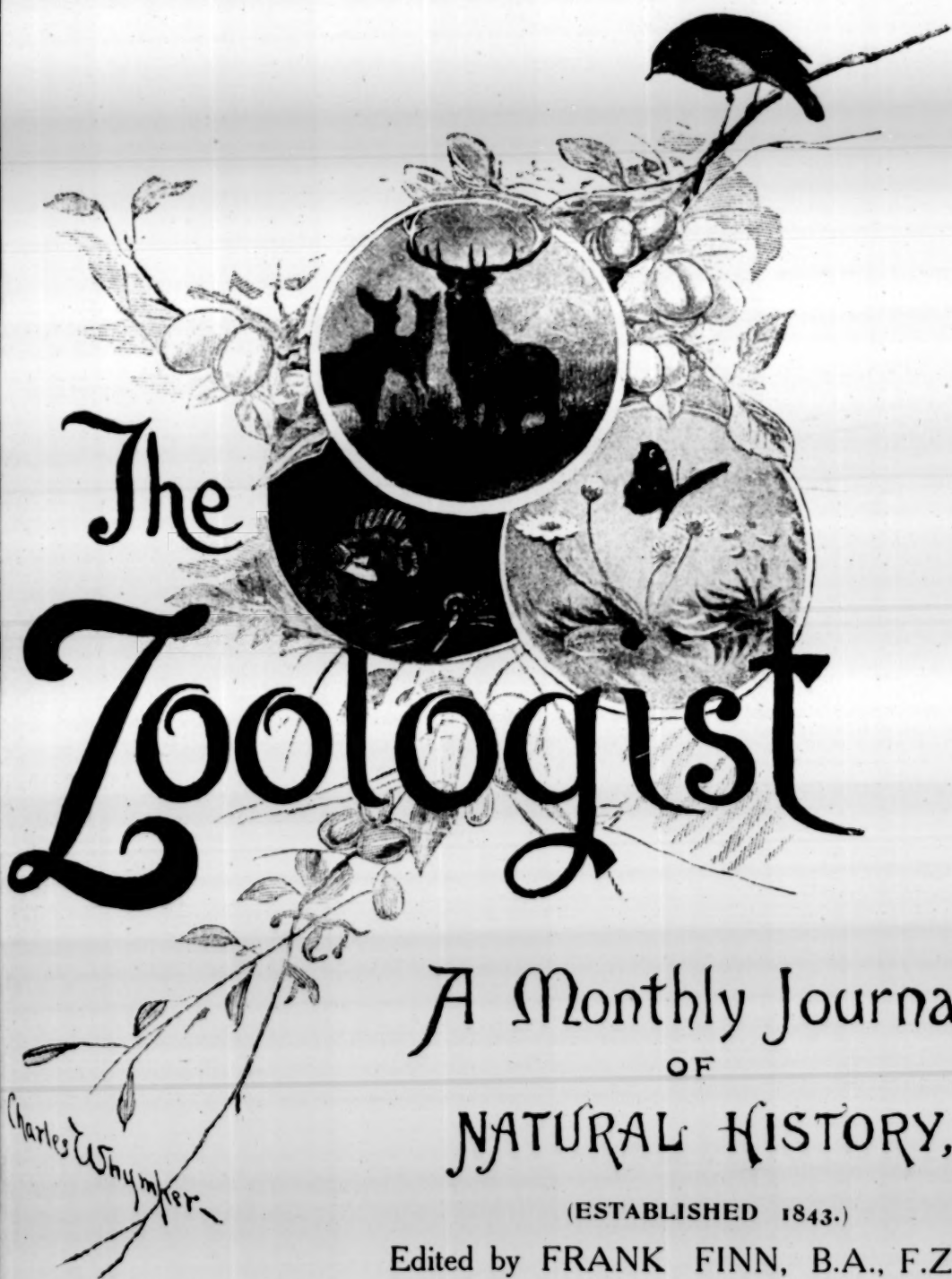
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
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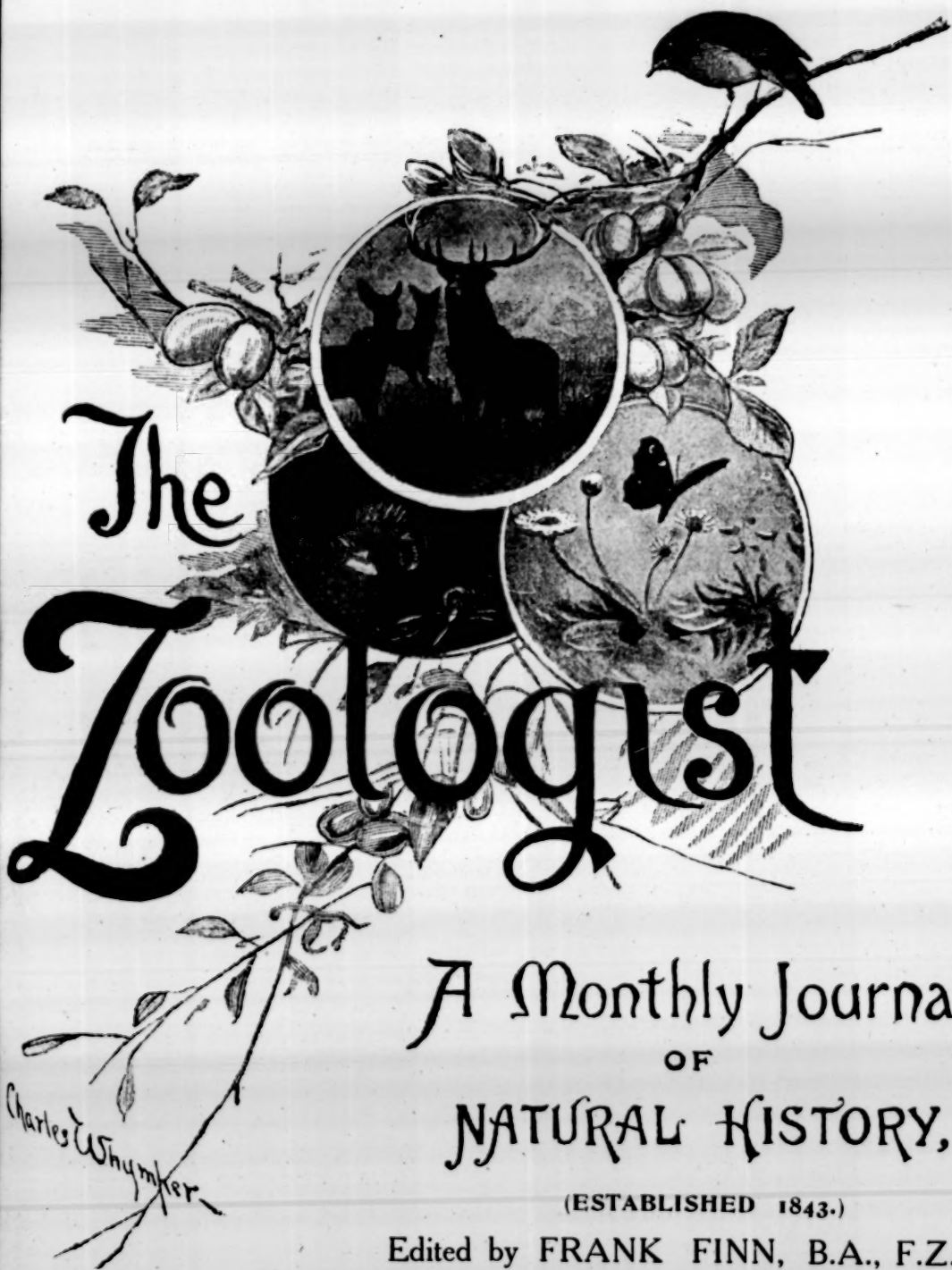
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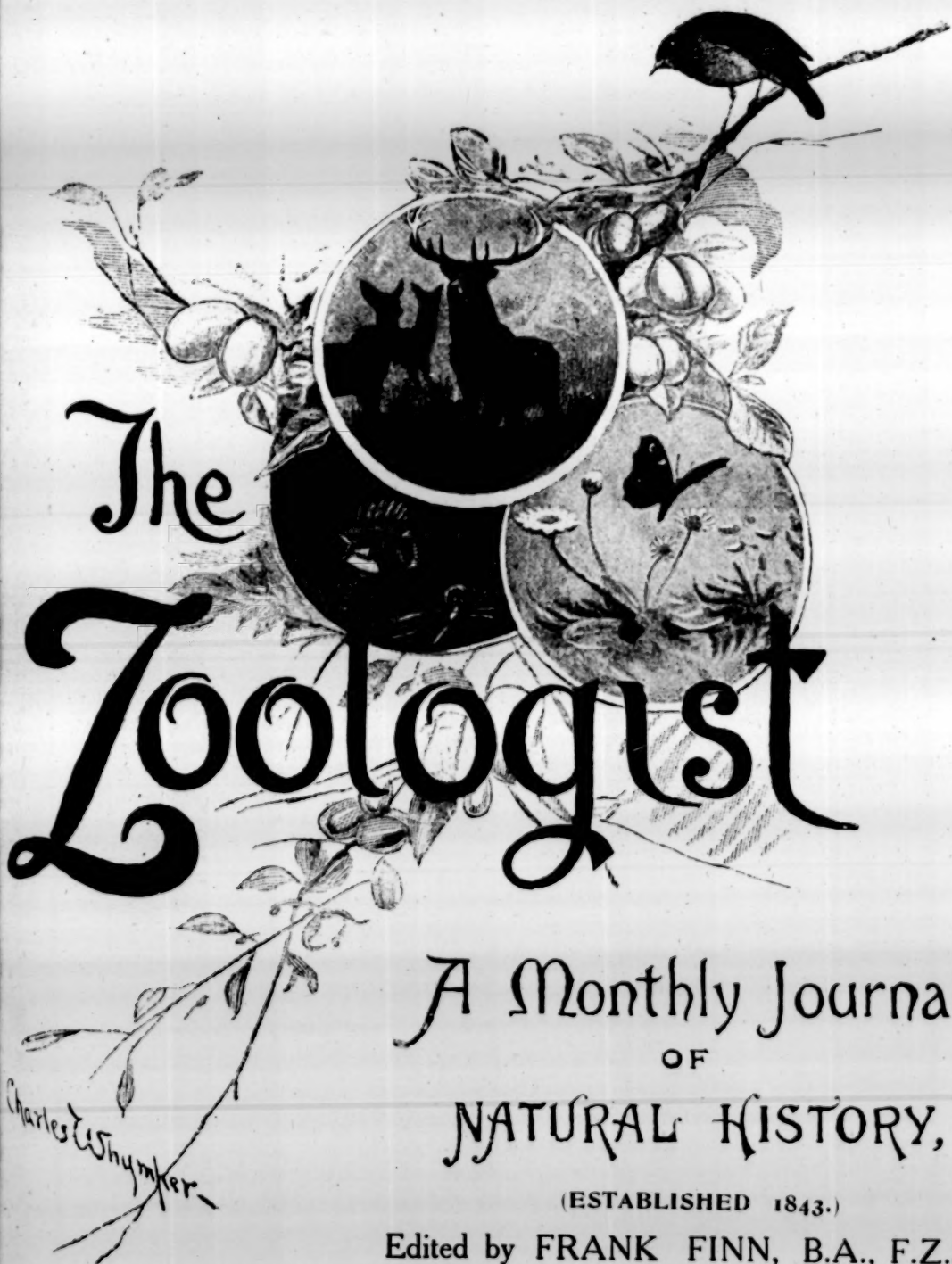
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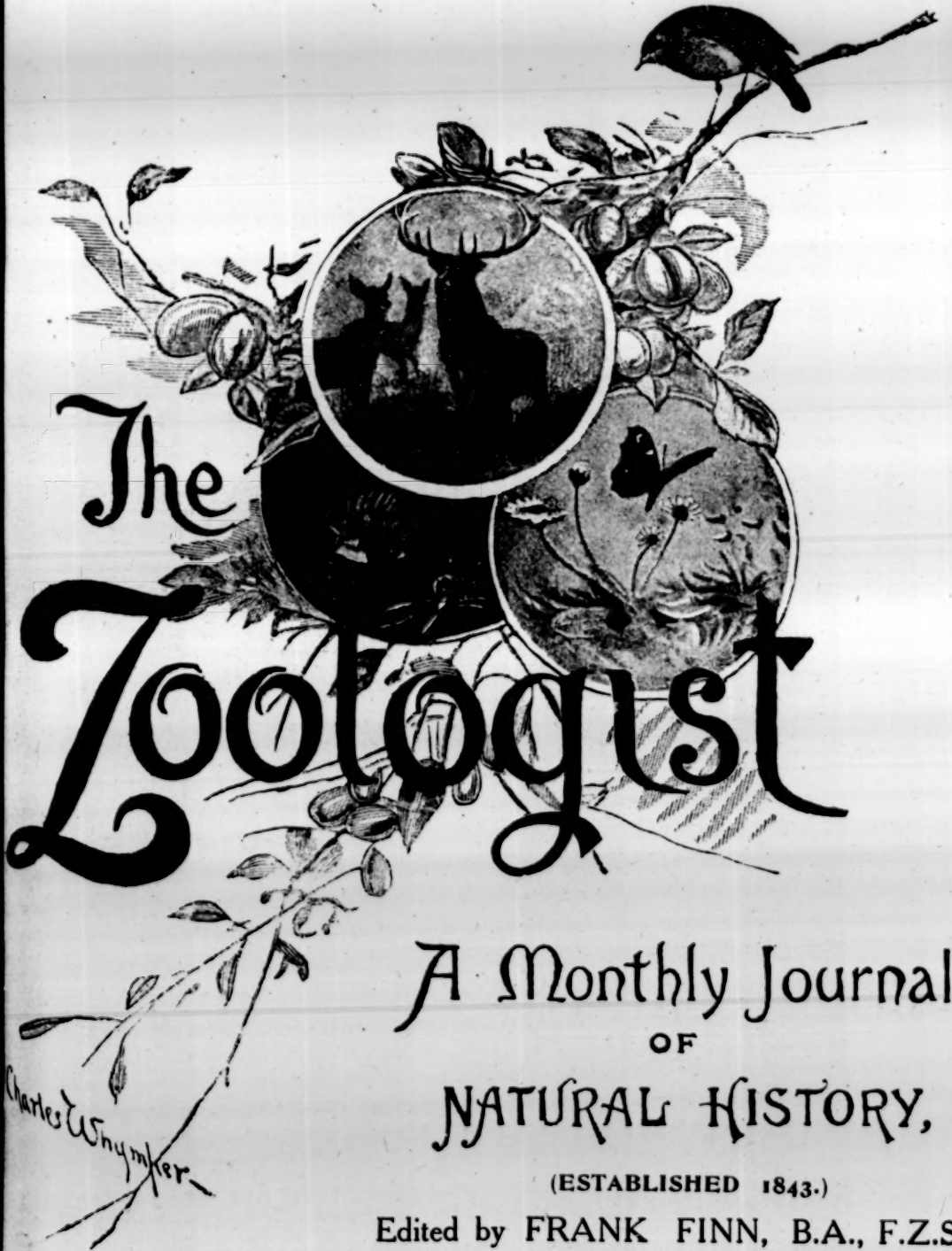
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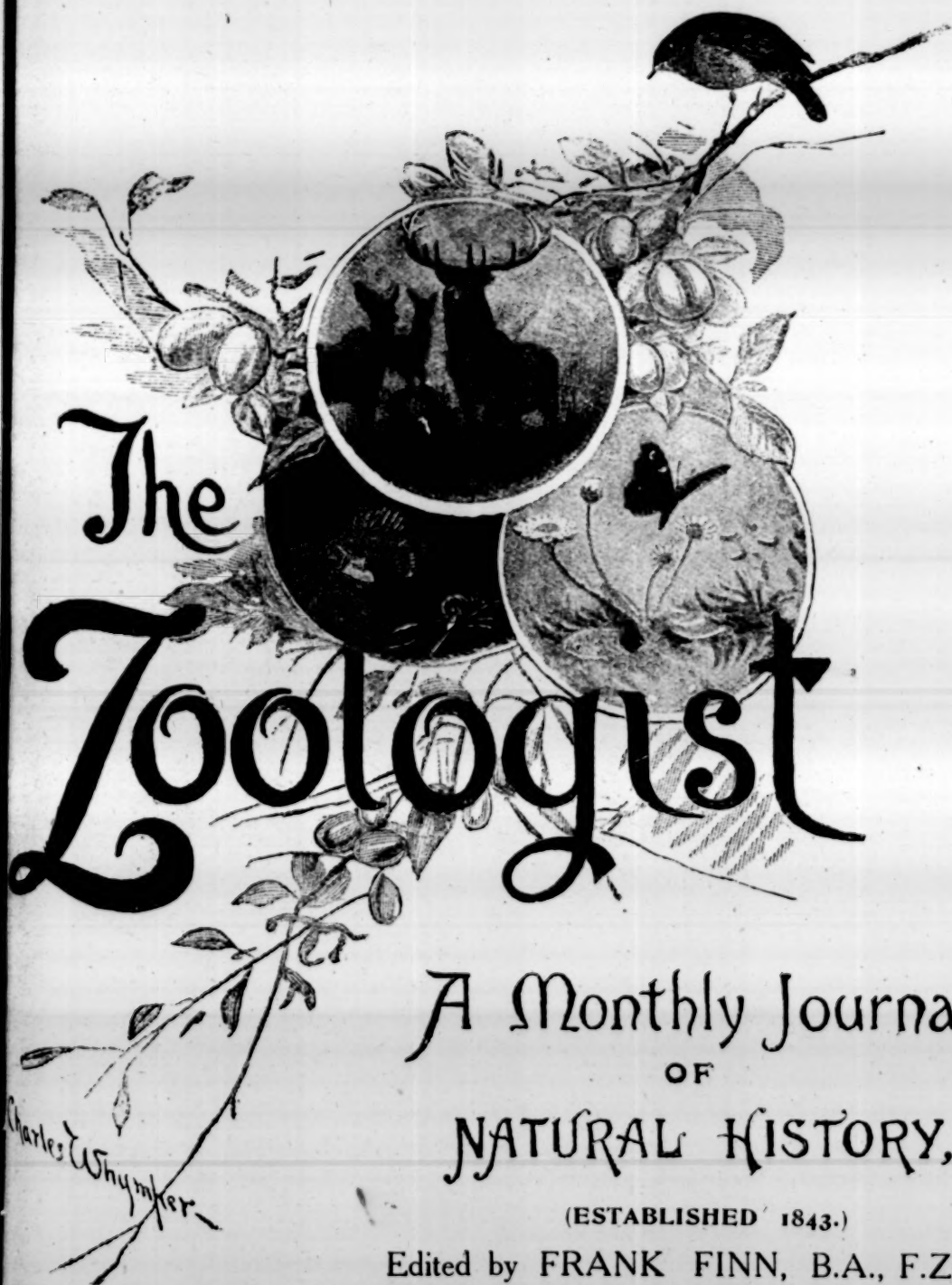
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
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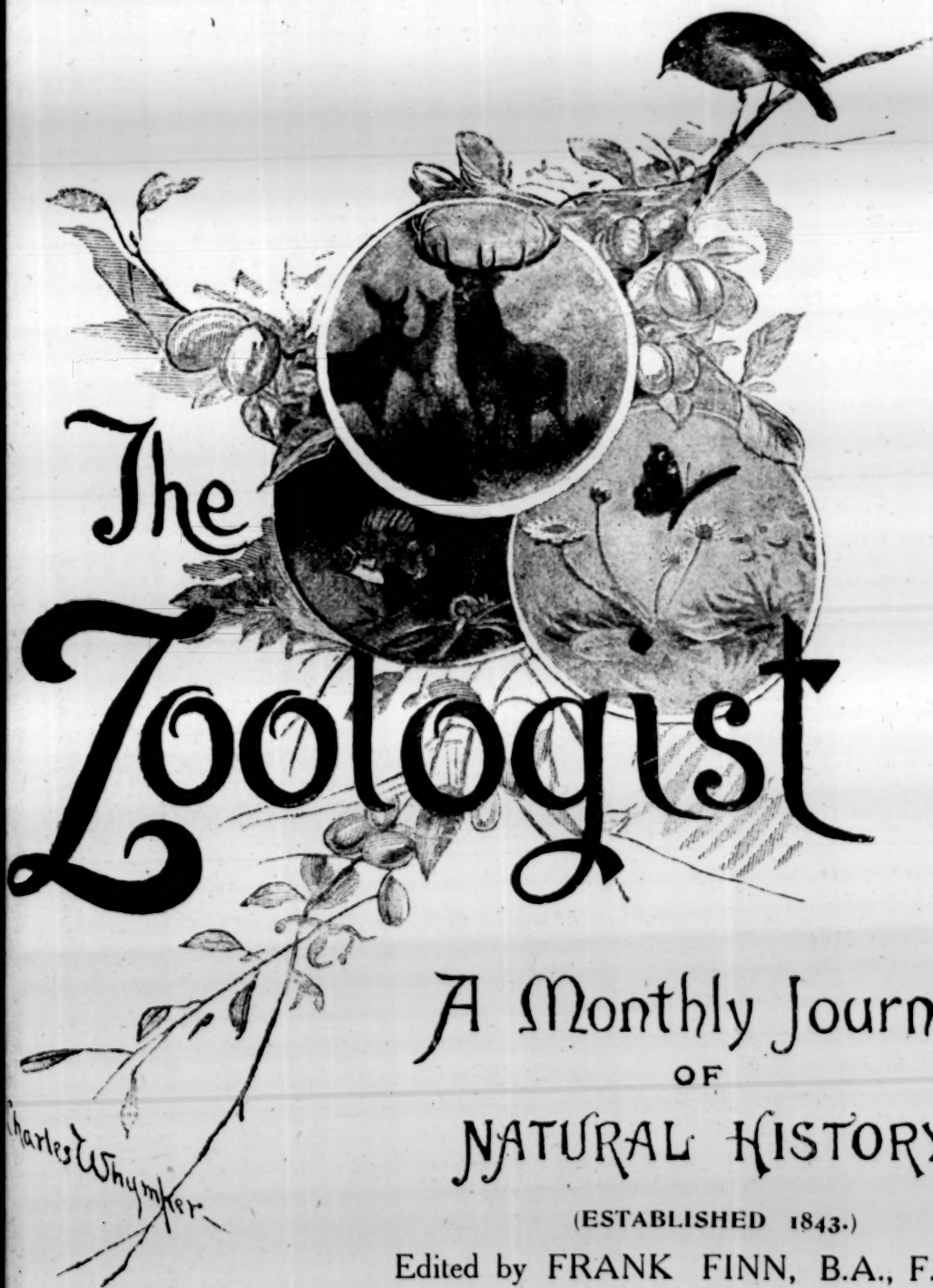
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
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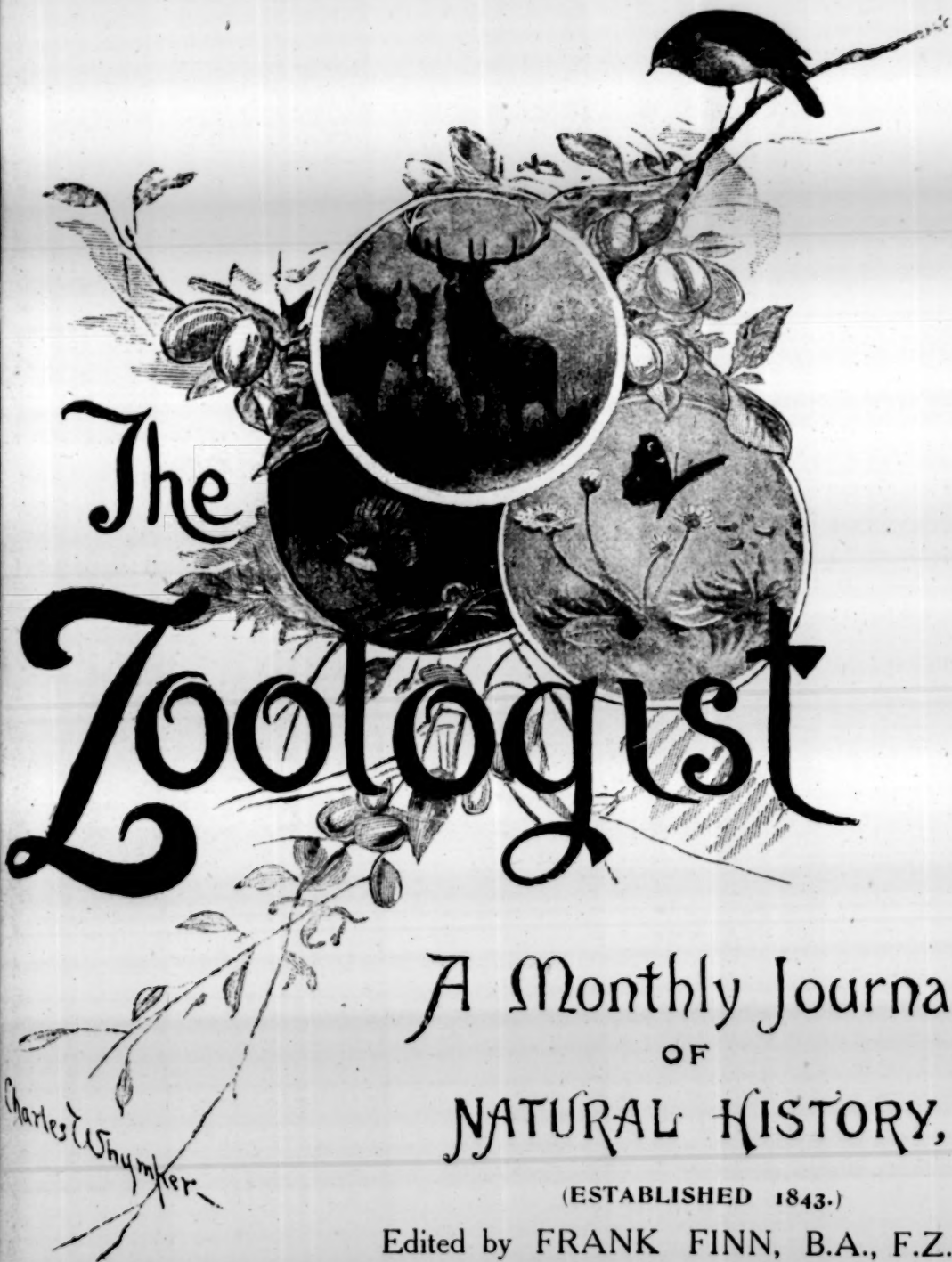
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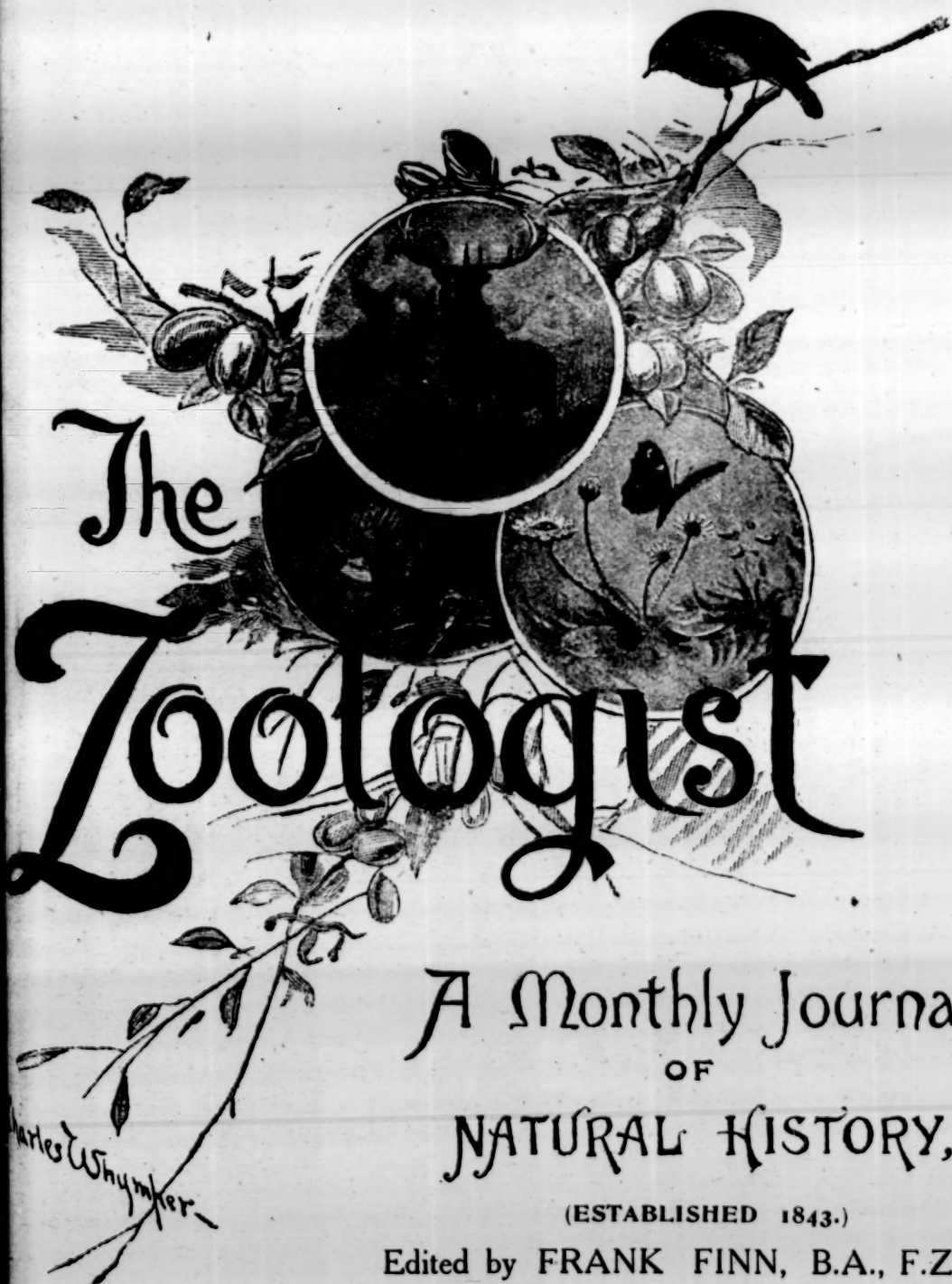
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
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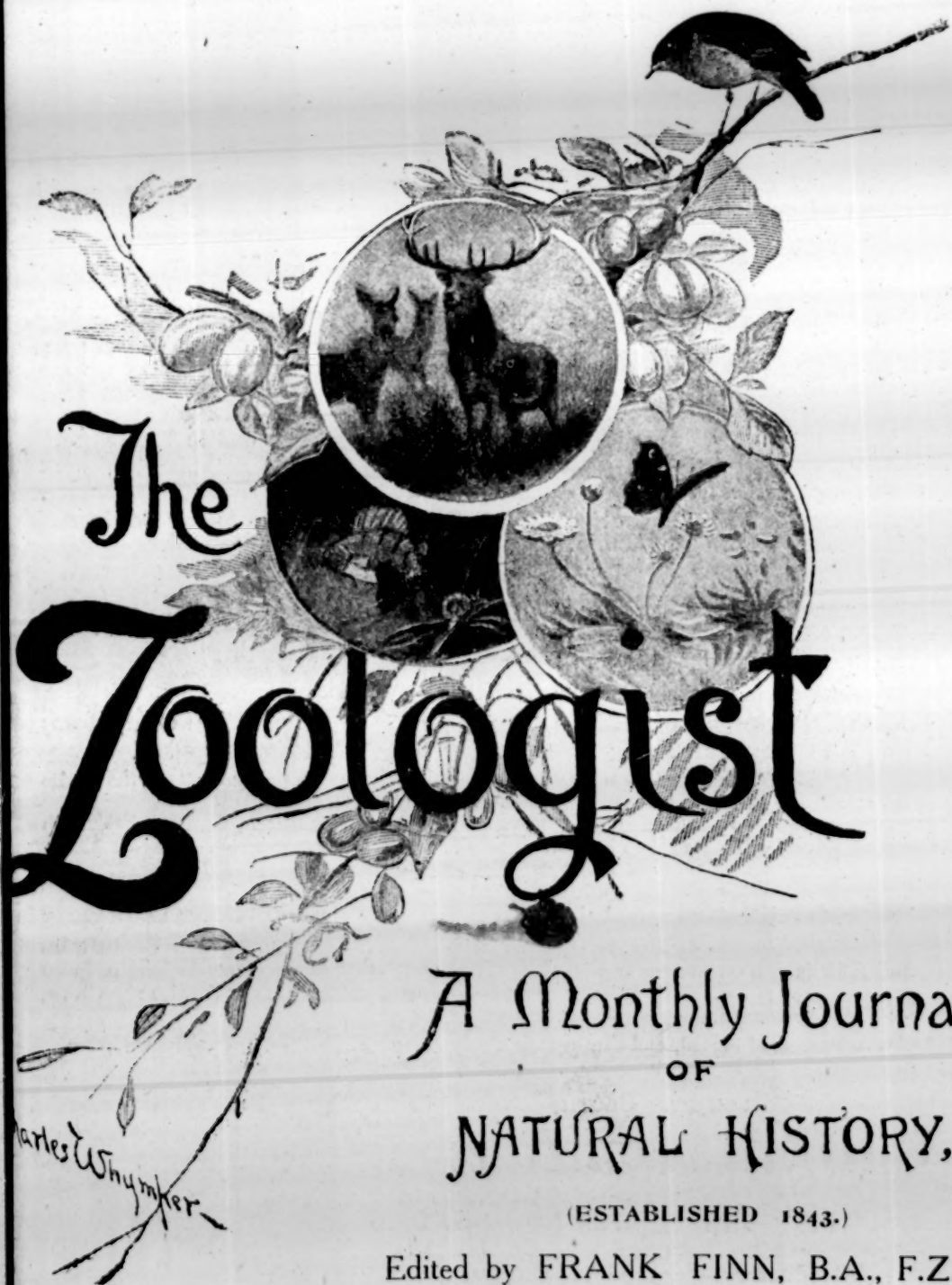
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